CHANGE REQUEST for FY 08-09 BUDGET REQUEST CYCLE

Department:	Natural Resources
Priority Number:	8 of 18
Change Request Title:	Renewable Geothermal Energy for Colorado

SELECT ONE (click on box):

☒ Decision Item FY 08-09
☐ Base Reduction Item FY 08-09
☐ Supplemental Request FY 07-08
☐ Budget Request Amendment FY 08-09

SELECT ONE (click on box):

Supplemental or Budget Request Amendment Criterion:
☒ Not a Supplemental or Budget Request Amendment
☐ An emergency
☐ A technical error which has a substantial effect on the operation of the program
☐ New data resulting in substantial changes in funding needs
☐ Unforeseen contingency such as a significant workload change

Short Summary of Request:

The Colorado Geological Survey (CGS) requests an increase of $72,392 cash funds in its base revenue from the Operational Account of the Severance Tax Trust Fund and one additional full-time equivalent (FTE) to investigate and develop data regarding Colorado's geothermal energy resources.

Background and Appropriation History:

Since late 2005, CGS has attempted to revitalize its geothermal studies. Due to advancing technologies, there is now potential for electrical generation in Colorado from geothermal energy. In this effort, CGS is cooperating with the Governor's Energy Office and the Colorado Geothermal Working Group to update CGS's geothermal resource picture. Because of its importance to Colorado, CGS began this work with parts of existing employees, whose workloads were already full, and a part-time consultant. CGS foresees a long-term need for the required expertise. This need is threefold: 1) Colorado has a continuing need for new renewable energy resources to help meet the state's "20% by 2020" renewable portfolio standard; 2) the amount of scientific work and related economic analysis needed to attract geothermal energy investment will take multiple years; and 3) escalating demand and cost for energy will make geothermal energy development progressively more economical and attractive.

Economically accessible geothermal heat is controlled by the underground geology and by the movement of groundwater in relation to the heat source. CGS has much expertise in both areas. CGS published over 30 specific studies about geothermal resources in the 1970s and early 80s, before state and federal funding for geothermal research was cut. CGS has been the primary organization to investigate geothermal resources in the state. Universities and colleges in Colorado have done relatively little work on this subject and have essentially left this work to CGS. Although it has been 25 years since significant geothermal investigations were conducted in Colorado, what is known today is largely a result of past CGS work.

Geothermal energy is a renewable energy resource that is underdeveloped in Colorado in two ways. The state has potential to generate electrical power from geothermal energy but currently does not produce any electrical power from this source. Also, Colorado can expand direct use of geothermal waters for space heating, agriculture, aquaculture, recreational pools, and other uses. The State needs to study, investigate, and develop more scientific information regarding its geothermal resources to attract investment in this clean energy source.

The technology to generate electricity from geothermal energy has advanced significantly in the past 25 years. CGS data suggests that geothermal resources in Colorado are capable of generating electricity with today's technology.

Indeed, the Western Governor's Association released a report in 2006 estimating that Colorado has the geothermal potential to produce 20 megawatts (MW) of electricity in the near term (2015) and possibly 50 MW in the long term. A more recent (February 2007) Massachusetts Institute of Technology report, "The Future of Geothermal Energy," indicates that Colorado has significant geothermal resources at depths below 11,000 feet. At these depths, Colorado has one of the best high-temperature geothermal resources in the U.S.

A devoted effort is required to gather known information, add new information, and coordinate with Governor's Energy Office, state agencies, private industry, and other

geothermal groups to tap this geothermal potential. Geothermal energy can produce renewable, clean, base-load power for Colorado that is *reliable*. Base-load power is power that is consistently available 24 hrs a day, 7 days a week. Of all the renewable energy sources, geothermal energy is the best for base-load power. The time is ripe to pursue geothermal energy resources again.

CGS's scientific studies can also contribute greatly to promoting and increasing the direct use of geothermal heat in Colorado. CGS has identified 56 geothermal resource areas that could potentially provide hot water and heat to up to a total of 100,000 homes or businesses.[1] Currently, only a fraction of that number is taking advantage of available geothermal waters. Greenhouses and aquaculture can take advantage of lower temperature geothermal waters, making these businesses feasible in high altitude settings. Geothermal pools and spas already attract many tourists to Colorado. Additional geothermal-related recreational sites can enhance tourism and spread its economic impact to more rural areas of the central mountains and western slope.

Because of the legislature's recent funding of the Colorado Renewable Energy Collaboratory, it may be helpful to clarify why the CGS should be conducting geothermal research and how this request fits with the Collaboratory's efforts:

- CGS has a long-term history of work in geothermal energy. CGS has over 33 publications of geothermal investigations dating back to the mid 1970s. The geological nature of this renewable resource argues that the State geological survey ought to be the agency that performs the scientific work needed for development of the resource. In fact, CGS has been working with the Governor's Energy Office since December 2005 on new investigations to develop updated maps of our geothermal resources. This work was started well *before* the creation of the Collaboratory and was initiated by the State Geologist in earlier conversations with the Governor's Energy Office. Both historical precedent and current activity confirm that geothermal research and applied science activity should be <u>enhanced</u> at the CGS and not consigned to the Renewable Energy Collaboratory.

[1] Cappa and Hemborg, 1995, Low Temperature Geothermal Assessment Program, Colorado, CGS OFR 95-1; Bob Lawrence & Associates, Inc., July 2006.

- The amount of Colorado-focused geothermal research among the members of the Collaboratory pales in comparison with CGS. In practice, the Collaboratory's focus is predominantly on wind, solar, and biofuels energy research. In that environment, geothermal research may not receive the attention it needs to prosper. The new CGS FTE position would cooperate with the Renewable Energy Collaboratory to ensure there is no duplication of effort and, moreover, would work to enable synergies between geothermal resources and the other renewable technologies.
- CGS is located within State Government and can address resource development issues related to leasing and regulation cooperatively with the other state agencies in the Department of Natural Resources that have statutory authority in these areas. This role is specifically mandated for CGS by statute [C.R.S. 34-1-103 (1) (j) (2006)]. This inter-agency link will facilitate geothermal development in Colorado by helping in the transition from *investigation*, to *identification*, to *implementation* of projects.

CGS is well positioned to take the lead on geothermal research and advance Colorado's use of clean reliable energy.

The Environmental Geology and Geologic Hazards Long Bill Line Item appropriation had no overall increases in FY05 and FY06 (for budget years FY06 and FY07). For budget year FY06 there were two one-time fund switches. The first was a fund switch of $21,000 from cash fees to severance tax to develop a report on underground water storage (SB06-193). The second was the FY06 Long Bill (HB06-1385), which switched $33,000 of cash fees to severance tax to provide CGS support for a coalbed methane stream depletion study change request which was funded under a separate long bill line. Both of these changes expired in FY07 and the amounts reverted to cash fees.

During figure setting last year (for budget year FY08), a portion of Change Request #7 , Address Current and Emerging Geologic Issues, was approved, increasing the severance tax appropriation by $75,888. However, the cash exempt appropriation was decreased by $251,237 with a corresponding decrease of 2.0 FTE (from 18.2 to 16.2). In addition, Change Request #22, Increase Land Use Review Fees, was approved with an increase of $105,281 to cash fees and a corresponding decrease of the same amount in the severance tax appropriation.

General Description of Request:

CGS currently does not have the FTE allocation to address geothermal energy research, data acquisition, and communication with the geothermal industry on a consistent basis; such that, a vigorous geothermal energy industry is encouraged to develop in Colorado. Currently, CGS can only address the need for geothermal data with fractions of existing FTE (whom already have full workloads) and with a part-time consultant – and this only through grant funding that is uncertain in amount and duration. An FTE and funding, fully devoted to geothermal research, are required to maintain the current effort to advance geothermal knowledge on a consistent basis and to continue to enhance those efforts into the future. A dedicated FTE will be able to maintain a body of institutional knowledge within State government to meet the needs of state agencies, and encourage development of our geothermal resources. The FTE position will also be required to have crossover skills in groundwater resource geology to assist, when needed, in CGS's groundwater resource characterizations.

Geothermal research is mandated for the CGS by statute in C.R.S. 34-1-103 (1)(j) (2006): "*To advise the state engineer in the promulgation of rules and regulations pursuant to article 90.5 of title 37, C.R.S., and to provide other governmental agencies with technical assistance regarding geothermal resources as needed.*"

CGS had a robust geothermal program until 1983, when its general funding was significantly reduced. Coincidently, the energy crisis of the late 1970s and early 1980s waned, and with it, the perceived need for geothermal energy research in the U.S. by state and federal government, and the private sector. Since that time, CGS has performed geothermal investigations only when external grant funding has been available to match limited internal funding.

Because of the increase in energy costs in the 21st Century, and the desire to develop renewable forms of energy, the need for consistent funding for geothermal energy research in Colorado has returned. Therefore, CGS is requesting this budget change of 1.0 FTE and $72,392.

This increase in funding and FTE would provide CGS with the resources to re-invigorate its historic work in geothermal energy – a renewable and greenhouse gas neutral energy

source. Granting of this request will allow CGS to perform an important role in moving Colorado toward a new energy economy.

Consequences if Not Funded:

Without a defined FTE who can devote a significant amount of effort to the geothermal program, Colorado will fall farther behind other states in being able to attract capital investment to this clean energy source at a time when citizens have expressed interest in increasing the availability of renewable energy. Geothermal is the best of the renewable alternatives because it is non-polluting and because it is the only renewable that can be used for *base-load* electricity.

Without funding for geothermal investigations, the Central Mountains, Western Slope, and Southeast areas of Colorado could lag in participating in the new energy economy. Geothermal resources are predominantly located in these areas, whereas, wind, solar, and biofuels are generally abundant in the High Plains and San Luis Valley. Geothermal resources are complimentary in geographic location to other renewable energy resources.

Without a dedicated scientist CGS will have to call upon geologists who already have a full plate of responsibilities and cannot devote significant attention to geothermal resource development. In addition, if contractors are hired to perform geothermal research on grant-dependent funding, the knowledge and personal contacts developed during a project will be lost when the project terminates. At least one FTE is necessary to maintain a coherent geothermal resource development program at the State level. This position will perform geothermal investigations, apply for external grants and funding, and manage hired contractors.

Calculations for Request:

Summary of Request FY 08-09	Total Funds	General Fund	Cash Funds	Cash Funds Exempt	Federal Funds	FTE
Total Request			$72,392			1.0
Salary			$59,664			

Summary of Request FY 08-09	Total Funds	General Fund	Cash Funds	Cash Funds Exempt	Federal Funds	FTE
PERA			$6,056			
FICA			$865			
Amortization Equalization Disbursement (AED)			$955			
Supplemental Amortization Equalization Disbursement (SAED)			$447			
Operating Expenses			$4,405			

Summary of Request FY 09-10	Total Funds	General Fund	Cash Funds	Cash Funds Exempt	Federal Funds	FTE
Total Request			$69,235			1.0
Salary			$59,664			
PERA			$6,056			
FICA			$865			
Amortization Equalization Disbursement (AED)			$955			
Supplemental Amortization Equalization Disbursement (SAED)			$298			
Prior Year SAED			$447			
Operating Expenses			$950			

Assumptions for Calculations:

Salary calculation is based on $4,972 per month for a Physical Science Researcher/Scientist II position (range minimum).

In accordance with calculation instructions from OSPB, PERA is calculated at 10.15% and FICA is calculated at 1.45% of base pay. Operating expenses for the first year consist of:

Supplies	$	500
Computer (desktop)	$	900
Office Suite Software	$	330
Office Equipment	$	2,225
Telephone Base	$	450
Total Operating Expenses, Year 1	**$**	**4,405**

For year 2 (FY09-10), Operating expenses consist of Supplies at $500 and annual telephone base at $450. Salary base, PERA, and FICA remain the same. Prior year Supplemental Amortization Equalization Disbursement (SAED) is added to the personal services base.

Impact on Other Government Agencies:

Not applicable.

Cost Benefit Analysis:

The cost impact of hiring one FTE is weighed against the environmental benefit of eliminating carbon dioxide (CO_2) emissions that would otherwise occur, if a 10-megawatt (MW) geothermal power plant displaces 10 MW of coal-fired power.

The cost of hiring an FTE to investigate and develop data on geothermal resources in Colorado is **$70,000/year** (rounded). If, by the work of this FTE, Colorado is able to attract a 10-MW geothermal power plant, many tons of CO_2 emissions would be prevented. CO_2 emissions have an environmental cost that is difficult to quantify. One way to quantify this is to determine what it would cost a fossil fuel power plant to sequester its CO_2 emissions. This allows a direct "business-model" method of assessing the cost of CO_2 emissions.

CGS recently completed a study titled, "*CO_2 Sequestration Potential of Colorado*," that quantified the costs related to carbon sequestration[2]. In Colorado, fossil-fuel based power plants produce between 0.4 to 1.8 tons CO_2 per megawatt-hour (MWh) of power produced, depending on fuel type.[3] For purposes of this analysis an average of 1 ton CO_2/MWh of power generated will be used. Geothermal power plants emit some CO_2, but it is a small fraction of fossil fuel power plant emissions. Geothermal power emits 0.09 tons CO_2/MWh.[4] Net CO_2 emission savings for geothermal power generation is **0.91 tons CO_2/MWh**

The costs to capture, transport, and sequester CO_2 range from $62-65/ton for conventional power plants.[5] A cost of **$62/ton CO_2** will be used in this analysis.

The last number to define is the number of megawatt-hours a 10-MW power plant produces per year. Assuming the power plant is 90% efficient (online 90% of the year), a 10-MW power plant will produce **78,840 MWh/year**.

Determining the net cost to sequester CO_2 emissions for 10-MW fossil fuel power plant for one year:
0.91 tons CO_2/MWh x $62/ton CO_2 x 78,840 MWh/year = ~$4,400,000/year

Proposed Action	Estimated Benefit	Estimated Cost	Benefit – Cost Ratio
Add 1.0 FTE and increase base severance tax funding	▪ **$4,400,000/year** – This is the cost of CO_2 sequestration that is avoided by displacing 10-MW of fossil fuel power generation with a 10-MW geothermal power plant	▪ $70,000/year for 1.0 FTE	$4,400,000 / $70,000 or **63 to 1**

[2] Young, B.C.G. and others, 2007, CO2 Sequestration Potential of Colorado, Colorado Geological Survey Resource Series 45.
[3] Young, B.C.G. and others, 2007, CO2 Sequestration Potential of Colorado, Colorado Geological Survey Resource Series 45, pages 2-12, 2-13 and Table 2.5.
[4] Bloomfield, K.K., and Moore, J.N., 1999, Geothermal Electrical Production CO_2 Emissions Study, *presented* at Geothermal Resource Council 1999 Annual Meeting, Idaho National Engineering and Environmental Laboratory, INEEL/CON-99-00655 PREPRINT.
--- Value given is 0.18 lbs CO_2 /kilowatt-hour (kWh). Translation to tons CO_2/megawatt-hour (MWh):
0.18 lbs CO_2 /kWh x 1000 kWh/MWh x 1 ton/2000 lbs = 0.09 tons CO_2/MWh
[5] Young, B.C.G. and others, 2007, CO2 Sequestration Potential of Colorado, Colorado Geological Survey Resource Series 45, pages 7-6, 7-7 and Table 7.4.

Implementation Schedule:

Task	Month/Year
Write Position Description Questionnaires and Personnel Action Request	May, 2008
Open the Application Window to the Public	May, 2008
Review, Interview, and Hire New Positions	June, 2008
FTE Hired / New Employee Begins	July, 2008

Statutory and Federal Authority:

Section 34-1-103, C.R.S. (2006) Objectives of survey - duties of state geologist.
[Many statutory clauses apply generally to CGS duties regarding geologic studies including geothermal studies. Item (1)(j) applies specifically to geothermal studies]

(1) The Colorado geological survey shall function to provide assistance to and cooperate with the general public, industries, and agencies of state government, including institutions of higher education, in pursuit of the following objectives, the priorities of which shall be determined by mutual consent of the state geologist and the executive director of the department of natural resources:
(a) To assist, consult with, and advise existing state and local governmental agencies on geologic problems;
(c) To conduct studies to develop geological information;
(e) To collect and preserve geologic information;
(f) To advise the state and act as liaison agency on transactions dealing with natural resources between state agencies and with other states and the federal government on common problems and studies;
(g) To evaluate the physical features of Colorado with reference to present and potential human and animal use;
(h) To prepare, publish, and distribute reports, maps, and bulletins when necessary to achieve the purposes of this part 1, but in accordance with section 24-1-136, C.R.S.;
(j) To advise the state engineer in the promulgation of rules and regulations pursuant to article 90.5 of title 37, C.R.S., and to provide other governmental agencies with technical assistance regarding geothermal resources as needed;

(2) The duties of the state geologist shall be to fulfill the objectives of this part 1 and, together with the employees of the survey, work for the maximum beneficial and most

efficient use of the geologic processes for the protection of and economic benefit to the citizens of Colorado.

(3) The state geologist shall conduct a study and prepare a map or maps as provided in section 34-1-303.

(6) The state geological survey shall prepare an annual report describing the status of the mineral industry and describing current influences affecting the growth and viability of the mineral industry in the state, and setting forth recommendations to foster the industry. This report and recommendations shall be submitted to the director of minerals and geology.

[Note: This report includes energy resources and is published by the CGS as the "Colorado Mineral and Energy Industry Activities, *(year)*" report]

Section 37-90.5-102, C.R.S. (2006) Legislative declaration.
(1) The general assembly hereby declares that:

(a) The development of geothermal resources is in the public interest because it enhances local economies and provides an alternative to conventional fuel sources;

(b) The development of geothermal resources should be undertaken in such a manner as to safeguard life, health, property, public welfare, and the environment and to encourage the maximum economic recovery of the resource and prevent its waste;

Section 39-29-109, C.R.S. (2006) Severance tax trust fund - created - administration - use of moneys - repeal.
(1) (a) There is hereby created in the office of the state treasurer the severance tax trust fund. The fund is to be perpetual and held in trust as a replacement for depleted natural resources and for the development and conservation of the state's water resources pursuant to sections 37-60-106 (1) (j) and (1) (l), 37-60-119, and 37-60-122, C.R.S., and for the use in funding programs that promote and encourage sound natural resource planning, management, and development related to minerals, energy, geology, and water.

Performance Measures:

CGS believes that this decision item is consistent with the Department's vision statement on energy as contained in the FY08-09 Strategic Plan for the Department of Natural Resouces. The energy vision statement is as follows:

Promote responsible and sustainable development of Colorado's energy and mineral resources in a manner that is consistent with environmental protection, maintenance of Colorado's quality of life, and protection of Colorado's diverse economic base. Promote renewable energy, innovative technology, and energy efficiency as part of sustaining Colorado's long term energy supply.

Performance Measure:	Outcome	FY 05-06 Actual	FY 06-07 Actual	FY 07-08 Approp.	FY 08-09 Request
Promote the responsible economic development of mineral and energy resources (expressed as the percent of counties in the state and state departments receiving assistance in mineral and energy resources from CGS).	Benchmark	5%	5%	5%	5%
	Actual	5%	10%		
This change request will increase the number of counties in the state and state departments receiving information and technical assistance from the Colorado Geological Survey. CGS expects, as part of this decision item, to interact with the following counties in the near-term: Chaffee, Dolores, and Saguache. This would increase the Performance Measure Actual for FY08-09 by 3.6%. The following counties have been identified as having areas of geothermal potential (direct use or electrical power) and may possibly be affected by this decision item in the long-term: Chaffee, Saguache, Las Animas, Fremont, Pueblo, Weld, Clear Creek, Routt, Gunnison, Ouray, La Plata, Archuleta, Garfield, and Lake.					